

WHAT IS CLAIMED IS:

1 1. A method of implementing load balancing in a
2 resilient packet ring ("RPR") network comprising a
3 plurality of nodes and first and second rings each
4 comprising a plurality of links for carrying information
5 between the nodes in a clockwise direction and a
6 counterclockwise direction, respectively, wherein
7 adjacent ones of the nodes are connected by two of the
8 links, the method comprising the steps of, for one of the
9 nodes:

10 determining whether a load imbalance exists at the
11 node in connection with a first class of service; and
12 responsive to a determination that a load imbalance
13 exists:

14 changing Bandwidth Broker ("BB") parameters at
15 the node for the first class of service to cause new
16 flows to be diverted from a more heavily loaded one of
17 the rings to a less heavily loaded one of the rings; and

18 changing Quality of Service ("QoS") parameters
19 at the node for the first class of service to improve
20 traffic performance on the more heavily loaded one of the
21 rings, while increasing bandwidth utilization on the less
22 heavily loaded one of the rings.

1 2. The method of claim 1 wherein the step of
2 determining is performed at periodic time intervals.

1 3. The method of claim 1 wherein the step of
2 determining is performed using a technique selected from
3 the group consisting of measuring and comparing delays
4 experienced by a test packet sent from the node to a
5 second node via the first and second rings, respectively,
6 and comparing a number of dropped packets on the first
7 and second rings with a preselected maximum value.

1 4. The method of claim 1 further comprising the
2 step of signaling to a QoS/BB monitor that a load
3 imbalance has been detected responsive to a determination
4 that a load imbalance exists.

1 5. The method of claim 1 wherein the step of
2 changing the BB parameters comprises the steps of:
3 decreasing an allocated bandwidth for the first
4 class of service on the more heavily loaded ring; and
5 increasing an allocated bandwidth for the first
6 class of service on the less heavily loaded ring.

1 6. The method of claim 1 wherein the step of
2 changing the QoS parameters comprises the steps of:

3 setting the peak traffic rate to the used bandwidth
4 for the first class of service on the more heavily loaded
5 ring;

6 reducing token bucket ("TB") parameters for all
7 other classes of service on the more heavily loaded ring;

8 setting the peak traffic rate to the used bandwidth
9 for the first class of service on the less heavily loaded
10 ring; and

11 increasing the number of bytes in a class based
12 queue ("CBQ") for the first class of service drained off
13 in each scheduler rotation for each of the rings.

1 7. The method of claim 1 wherein the RPR network
2 is a wavelength division multiplex RPR and the first and
3 second rings are first and second wavelengths,
4 respectively.

1 8. Apparatus for implementing load balancing in a
2 resilient packet ring ("RPR") network comprising a
3 plurality of nodes and first and second rings each
4 comprising a plurality of links for carrying information
5 between the nodes in a clockwise direction and a
6 counterclockwise direction, respectively, wherein
7 adjacent ones of the nodes are connected by two of the
8 links, the apparatus comprising, at one of the nodes:

9 means for detecting at the node a load imbalance in
10 connection with a first class of service;

11 means responsive to detection at the node of a load
12 imbalance for changing Bandwidth Broker ("BB") parameters
13 at the node for the first class of service to cause new
14 flows to be diverted from a more heavily loaded one of
15 the rings to a less heavily loaded one of the rings; and

16 means responsive to detection at the node of a load
17 imbalance for changing Quality of Service ("QoS")
18 parameters at the node for the first class of service to
19 improve traffic performance on the more heavily loaded
20 one of the rings, while increasing bandwidth utilization
21 on the less heavily loaded one of the rings.

1 9. The apparatus of claim 8 wherein the means for
2 detecting performs the detecting at periodic time
3 intervals.

1 10. The apparatus of claim 8 wherein the means for
2 detecting comprises means for measuring and comparing
3 delays experienced by a test packet sent from the node to
4 a second node via the first and second rings.

1 11. The apparatus of claim 8 wherein the means for
2 detecting comprises means for comparing a number of
3 dropped packets on the first and second rings with a
4 preselected maximum value.

1 12. The apparatus of claim 8 further comprising
2 means for signaling to a QoS/BB monitor that a load
3 imbalance has been detected.

1 13. The apparatus of claim 8 wherein the means for
2 changing the BB parameters comprises:

3 means for decreasing an allocated bandwidth for the
4 first class of service on the more heavily loaded ring;
5 and

6 means for increasing an allocated bandwidth for the
7 first class of service on the less heavily loaded ring.

1 14. The apparatus of claim 8 wherein the means for
2 changing the QoS parameters comprises:

3 means for setting the peak traffic rate to the used
4 bandwidth for the first class of service on the more
5 heavily loaded ring;

6 means for reducing token bucket ("TB") parameters
7 for all other classes of service on the more heavily
8 loaded ring;

9 means for setting the peak traffic rate to the used
10 bandwidth for the first class of service on the less
11 heavily loaded ring; and

12 means for increasing the number of bytes in a class
13 based queue ("CBQ") for the first class of service
14 drained off in each scheduler rotation for each of the
15 rings.

1 15. The apparatus of claim 8 wherein the RPR
2 network is a wavelength division multiplex RPR and the
3 first and second rings are first and second wavelengths,
4 respectively.

1 16. Apparatus for implementing load balancing in a
2 resilient packet ring ("RPR") network comprising a
3 plurality of nodes and first and second rings each
4 comprising a plurality of links for carrying information
5 between the nodes in a clockwise direction and a
6 counterclockwise direction, respectively, wherein
7 adjacent ones of the nodes are connected by two of the
8 links, the apparatus comprising, at one of the nodes:

9 a Quality of Service/Bandwidth Broker ("QoS/BB")
10 monitor responsive to detection at the node of a load
11 imbalance in connection with a first class of service for
12 signaling to a BB to change BB parameters at the node for
13 the first class of service to cause new flows to be
14 diverted from a more heavily loaded one of the rings to
15 a less heavily loaded one of the rings and for changing
16 QoS parameters at the node for the first class of service
17 to improve traffic performance on the more heavily loaded
18 one of the rings, while increasing bandwidth utilization
19 on the less heavily loaded one of the rings.

1 17. The apparatus of claim 16 wherein detection of
2 a load imbalance is accomplished by measuring and
3 comparing delays experienced by a test packet sent from
4 the node to a second node via the first and second rings.

1 18. The apparatus of claim 16 wherein detection of
2 a load imbalance is accomplished by comparing a number of
3 dropped packets on the first and second rings with a
4 preselected maximum value.

1 19. The apparatus of claim 16 wherein the QoS/BB
2 monitor is apprised of a load imbalance via an in-band
3 signaling mechanism.

1 20. The apparatus of claim 16 wherein the QoS/BB
2 monitor is apprised of a load imbalance via an out-of-
3 band signaling mechanism.

1 21. The apparatus of claim 16 wherein the QoS/BB
2 monitor changes the BB parameters by:

3 decreasing an allocated bandwidth for the first
4 class of service on the more heavily loaded ring; and

5 increasing an allocated bandwidth for the first
6 class of service on the less heavily loaded ring.

1 22. The apparatus of claim 16 wherein the QoS/BB
2 monitor changes the QoS parameters by:

3 setting the peak traffic rate to the used bandwidth
4 for the first class of service on the more heavily loaded
5 ring;

6 reducing token bucket ("TB") parameters for all
7 other classes of service on the more heavily loaded ring;

8 setting the peak traffic rate to the used bandwidth
9 for the first class of service on the less heavily loaded
10 ring; and

11 increasing the number of bytes in a class based
12 queue ("CBQ") for the first class of service drained off
13 in each scheduler rotation for each of the rings.

1 23. The apparatus of claim 16 wherein the RPR
2 network is a wavelength division multiplex RPR and the
3 first and second rings are first and second wavelengths,
4 respectively.